Appendix E.8: Storm Surge

Storm surge hazard vulnerability was assessed for the population and the general building stock (residential, industrial, commercial, governmental, educational, agricultural and religious) and contents for the 23 parishes that could be inundated by a category 3 storm surge. Loss estimates were provided for the general building stock.

Hazard Ranking

The storm surge hazard ranking was based on the Annual Estimated Losses (AEL) as determined from HAZUS-MH general building stock data. Based on the flood depth and building characteristics, the damage functions for the general building stock were used to determine the AEL for each parish. The total of the Annual Estimated Losses for all the parishes is $47,714,074.

The high / medium / low rankings for each parish were developed by:

- Obtaining the Annual Estimated Loss data;
- Sorting the list by parish from highest to lowest losses;
- Assigning the high rank to parishes with losses greater than or equal to $15 billion;
- Assigning the medium rank to parishes where losses are less than $15 billion but greater than or equal to $250 million; and
- Assigning the low rank to parishes with losses less than $250 million.

The resulting ranked parishes are shown in in Table E-30. Map E-14 presents the ranking of all the parishes with high, medium and low risk to storm surge.

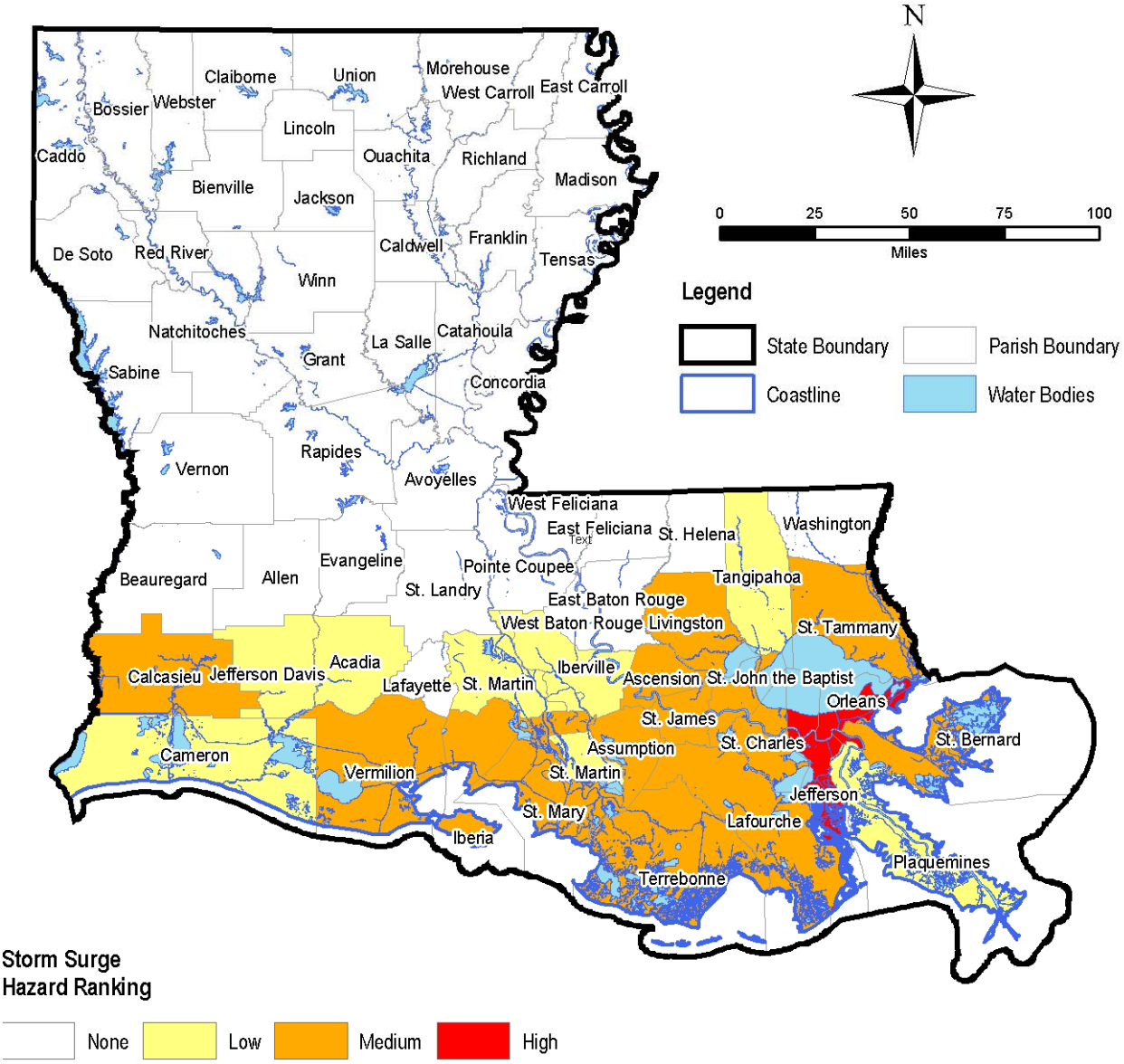
Table E-30. Category 3 Storm Surge Hazard Ranking for Louisiana Parishes

Rank	Parish	Surge AEL ($1,000)
1	Orleans	16,382,746
2	Jefferson	15,978,467
3	Terrebonne	2,106,954
4	Saint Bernard	1,840,364
5	Iberia	1,423,129
6	Saint Mary	1,398,657
7	Ascension	1,362,926
8	Lafourche	1,282,189
9	Saint Tammany	1,139,500
10	Saint Charles	918,117
11	Vermilion	888,637
12	Calcasieu	668,918
13	Saint John the Baptist	578,880
14	Livingston	371,485
15	Saint James	352,528
16	Assumption	319,941
17	Cameron	239,099
18	Plaquemines	140,309
19	Saint Martin	136,884
20	Jefferson Davis	67,019

Table E-30 (continued)

Rank	Parish	Surge AEL ($1,000)
21	Iberville	55,898
22	Tangipahoa	36,671
23	Acadia	24,756
	Total	47,714,074

Map E-14: Category 3 Storm Surge Hazard Ranking for Louisiana Parishes



Methodology

The HAZUS-MH inventory was developed as follows:

The HAZUS-MH general building stock data provides the building valuation for each specific occupancy classification (e.g., single family residential, retail trade) developed from the 2000 U.S. Census and Dun & Bradstreet. The general building stock data set includes the residential, commercial, industrial, governmental, educational, agricultural and religious buildings for each parish. This data was developed at the census block level and then aggregated at census tract level. This data set is from the 2000 version of TIGER/Line files and first quarter of 2002 data from D&B. The dataset was developed by applying RS Means replacement values for typical building floor areas and construction for each specific occupancy, which is a nationally accepted reference on building construction costs and is published annually.

Category 3 storm surge data was used to establish the depth of the surge, as it is analogous to the 100-year event. Storm surge data was provided from NOAA Sea, Lake and Overland Surges from Hurricanes (SLOSH) data (2004). SLOSH is a modeling tool used to estimate storm surge resulting from historical, hypothetical, or predicted hurricanes. In this analysis, color coded storm surge inundation areas were created and overlaid with census block data, defining the potential maximum surge for coastal locations for each category of hurricane, as well as exposed structures located in those areas.

Figure E-1. SLOSH Basins

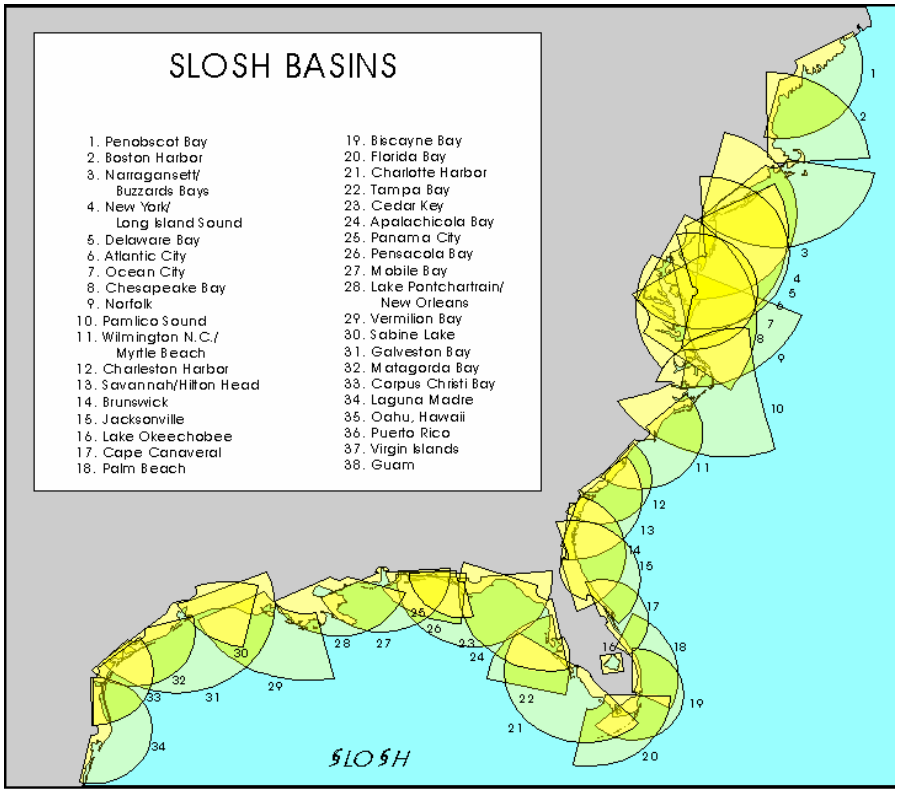
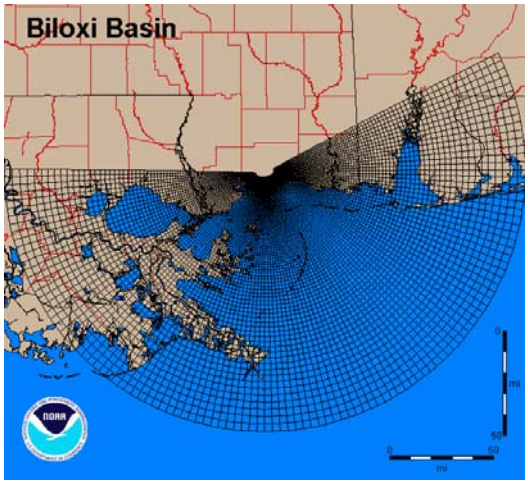
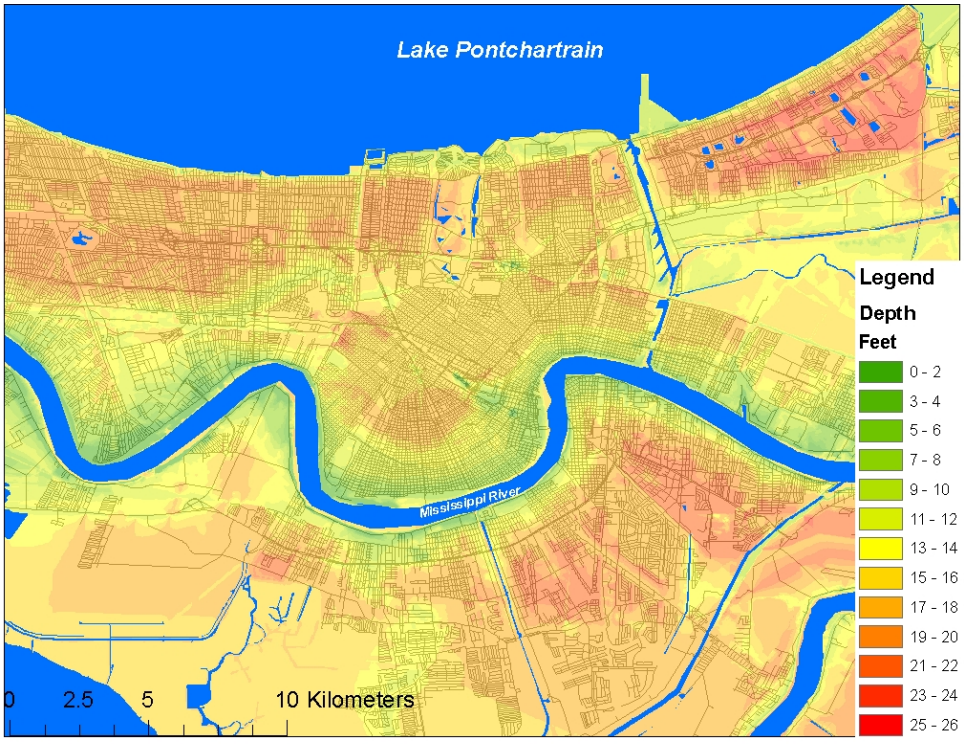


Figure E-2. Biloxi Basin



For developing the depth grid files, the SLOSH data was used in combination with ground elevation data from the USGS National Elevation Dataset. The maximum of the maximum (MOM) value (a composite measure that expresses the maximum flood elevation) for category 3 storm surge from the SLOSH data was used to determine the surge or water elevation. A GRID digital map of floor elevation was produced from the SLOSH shape file data. A simple GIS operation of subtraction was performed with the ground elevation data set to determine the water depth. The results of the storm surge depth calculations are shown in Figure E-3.

Figure E-3. Category 3 Storm Surge Depths



Using GIS analysis including parameters such as ground elevation, flood elevation, and typical finished floor levels in Louisiana, estimated depths of category 3 storm surge were produced for estimating exposure and losses for the general building stock. HAZUS-MH was used to determine exposure and loss estimates. The building stock and demographic data is aggregated at theblock level. In order to estimate the proportion of the block that is "inundated", an area-weighted approach is used. In the case of exposure, only the areas with water depth with values greater than zero were provided to estimate exposure. In this way, only the "flooded" area was considered.

Vulnerability to the storm surgfe hazard is based on the exposure of the population and general building stock to a Category 3 storm surge.. Exposure was based on the location of the population and structures within the category 3 storm surge inundation zones, which are based on the SLOSH data, where the calculated water depth is greater than zero.

The analysis for population exposure used U.S. Census 2000 overlaid with SLOSH data to determine the population located in the category 3 storm surge inundation area, where the calculated water depth is greater than zero. .

The analysis for general building stock exposure used HAZUS-MH general building stock data and SLOSH data. Aggregated building value data was overlaid with SLOSH data, where the calculated water depth is greater than zero, to determine general building stock exposure by summing the values for each parish.

The HAZUS flood wizard was used to estimate losses. Depth-Damage Functions (DDF -refer to Appendix F for more detailed discussion of DDFs) were used to correlate estimated losses with the estimated depth of water in the inundated areas. Based upon the flood depth and the building characteristics, the DDFs for the general building stock were used to determine AELs for each parish.

The AELs address the two key components of risk: the probability of the hazard occurring in the study area and the consequences of the hazard, which is a function of building construction type and quality, and of the intensity of the hazard event. The AEL results were reported for residential, industrial and commercial structures for each parish, as well as the total AEL for each parish. The typical floor elevation by occupancy in Louisiana census blocks (based on HAZUS-MH inventory) was used to determine the damage function.

Results

Of the 64 parishes in the State, 23 were determined to be vulnerable to a category 3 storm surge; these parishes are shown on Table E-31. The population and number of buildings exposed to category 3 storm surge hazard are presented in Table E-32 by parish. The building valuation and the estimated building loss exposed to a category 3 storm surge is presented in Tables E-33 and E-35, respectively.

Table E-31. Parishes Included in Surge Analysis

Acadia	Plaquemines
Ascension	Saint Bernard
Assumption	Saint Charles
Calcasieu	Saint James
Cameron	Saint John the Baptist
Iberia	Saint Martin
Iberville	Saint Mary
Jefferson	Saint Tammany
Jefferson Davis	Tangipahoa
Lafourche	Terrebonne
Livingston	Vermilion
Orleans	

Table E-32. Population and Number of Buildings Exposed to Category 3 Storm Surge

Parish	Population	Building Exposure (Number)					Total
		Residential	Commercial	Industrial	Governmental	Other	
Acadia	2,660	1,092	1	0	0	0	1,093
Ascension	65,320	26,433	160	9	4	6	26,612
Assumption	21,960	9,376	20	5	1	5	9,407
Calcasieu	87,650	35,375	348	33	8	16	35,780
Cameron	9,990	5,545	32	4	3	3	5,587
Iberia	70,950	26,140	177	11	7	8	26,343
Iberville	8,450	3,619	9	1	2	2	3,633
Jefferson	453,760	159,942	2,210	195	46	54	162,447
Jefferson Davis	4,990	2,311	7	1	1	1	2,321
Lafourche	89,940	35,181	240	7	10	14	35,452
Livingston	19,180	9,134	5	1	1	3	9,144
Orleans	484,430	154,310	1,759	94	86	81	156,330
Plaquemines	4,380	1,479	14	8	2	1	1,504
Saint Bernard	67,230	26,600	176	21	5	4	26,806
Saint Charles	48,000	18,500	95	19	11	10	18,635
Saint James	19,840	7,392	29	1	2	1	7,425
Saint John the Baptist	36,110	13,880	119	2	5	5	14,011
Saint Martin	17,420	7,507	9	1	1	2	7,520
Saint Mary	53,470	20,752	151	28	3	9	20,943
Saint Tammany	101,810	44,066	347	9	9	14	44,445
Tangipahoa	5,380	2,404	1	1	0	1	2,407
Terrebonne	104,440	40,170	354	41	13	27	40,605
Vermilion	104,440	21,748	85	1	8	5	21,847
Total	1,881,800	672,956	6,348	493	228	272	680,297

Table E-33. Population Exposed to Category 3 Storm Surge

Parish	Population
Orleans	484,430
Jefferson	453,760
Terrebonne	104,440
Vermilion	104,440
Saint Tammany	101,810
Lafourche	89,940
Calcasieu	87,650
Iberia	70,950
Saint Bernard	67,230
Ascension	65,320
Saint Mary	53,470
Saint Charles	48,000

Table E-33 (continued)

Parish	Population
Saint John the Baptist	36,110
Assumption	21,960
Saint James	19,840
Livingston	19,180
Saint Martin	17,420
Cameron	9,990
Iberville	8,450
Tangipahoa	5,380
Jefferson Davis	4,990
Plaquemines	4,380
Acadia	2,660
Total	1,881,800

Table E-34. Building Valuation Exposed to Category 3 Storm Surge

Parish	Building Exposure ($1,000)					Total
	Residential	Commercial	Industrial	Governmental	Other	
Orleans	35,516,620	2,820	0	0	0	35,519,440
Jefferson	33,637,643	551,079	111,338	5,740	48,138	34,353,938
Saint Bernard	4,671,109	99,362	36,312	3,466	34,662	4,844,911
Terrebonne	6,748,054	1,543,000	315,870	15,660	127,719	8,750,303
Saint Mary	3,196,056	105,951	47,759	6,574	28,634	3,384,974
Ascension	4,112,668	682,547	149,267	13,901	71,302	5,029,685
Iberia	4,117,178	17,396	4,563	6,880	8,958	4,154,975
Saint Tammany	8,559,050	7,470,301	1,312,320	88,207	489,097	17,918,975
Lafourche	5,876,938	21,876	2,724	666	3,664	5,905,868
Saint Charles	3,360,519	852,206	137,015	27,884	120,309	4,497,933
Vermilion	3,282,253	42,479	4,264	2,873	20,662	3,352,531
Calcasieu	6,217,272	6,736,259	894,080	162,962	598,823	14,609,396
Saint John the Baptist	2,510,270	58,062	47,329	2,530	3,976	2,622,167
Livingston	1,201,188	510,444	114,697	10,178	46,500	1,883,007
Saint James	1,156,009	321,900	172,429	26,853	62,040	1,739,231
Assumption	1,267,976	113,406	7,059	3,772	13,226	1,405,439
Cameron	747,773	317,452	26,984	8,666	40,622	1,141,497
Saint Martin	1,034,222	48,241	10,019	282	12,424	1,105,188
Plaquemines	226,555	578,870	192,613	10,215	77,980	1,086,233
Jefferson Davis	334,938	1,100,555	118,695	19,557	102,075	1,675,820
Iberville	490,100	3,816	1,428	0	3,430	498,774
Tangipahoa	315,748	1,243,372	447,583	27,990	177,158	2,211,851
Acadia	160,310	367,869	34,517	19,827	45,736	628,259
Total	128,740,449	22,789,263	4,188,865	464,683	2,137,135	158,320,395

Table E-35. Building Loss from Category 3 Storm Surge

Parish	Expected Loss ($1,000)					Total
	Residential	Commercial	Industrial	Governmental	Other	
Orleans	12,485,811	3,205,659	321,074	58,292	311,911	16,382,746
Jefferson	11,986,286	3,288,650	416,411	44,305	242,816	15,978,467
Terrebonne	1,503,675	360,241	162,983	7,183	72,873	2,106,954
Saint Bernard	1,562,041	212,830	34,364	6,294	24,835	1,840,364
Iberia	1,015,305	320,311	56,719	6,791	24,004	1,423,129
Saint Mary	1,043,813	231,175	76,291	3,509	43,870	1,398,657
Ascension	1,029,437	275,718	30,914	3,606	23,251	1,362,926
Lafourche	961,294	238,003	38,580	2,729	41,584	1,282,189
Saint Tammany	978,275	120,853	17,011	1,083	22,279	1,139,500
Saint Charles	774,414	83,079	37,272	1,488	21,865	918,117
Vermilion	741,142	118,744	11,216	5,130	12,405	888,637
Calcasieu	470,985	152,602	22,480	1,869	20,983	668,918
Saint John the Baptist	453,216	98,414	7,014	2,644	17,592	578,880
Livingston	343,107	18,999	1,360	286	7,733	371,485
Saint James	291,946	51,813	3,137	1,896	3,736	352,528
Assumption	253,395	43,793	6,455	1,138	15,159	319,941
Cameron	192,440	30,377	11,035	1,054	4,192	239,099
Plaquemines	90,046	26,996	20,391	0	2,875	140,309
Saint Martin	116,474	12,826	2,655	158	4,772	136,884
Jefferson Davis	59,454	4,721	992	0	1,853	67,019
Iberville	49,270	2,576	940	787	2,325	55,898
Tangipahoa	36,522	149	0	0	0	36,671
Acadia	23,961	795	0	0	0	24,756
Total ($1,000)	36,462,308	8,899,321	1,279,294	150,240	922,910	47,714,074

Data Limitations

Lafayette and East Baton Rouge Parishes were not considered in the analysis as only a very few SLOSH basin grids with water elevation values reached these Parishes. The ends of the SLOSH model lack resolution, making the interpolation exercise unreliable for estimating inundation depth.

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